# Africa Partnership Station: Coastal Processes

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## LONG-TERM GOALS

The goal of this research is to assist with the development of research capabilities of Gulf of Guinea nations and to increase the ability of these nations to understand, predict and mitigate coastal erosion hazards. This is being accomplished through sponsoring and developing the coastal processes research capabilities of these nations and their university systems. Initial activities are focusing on the research group within the Department of Oceanography and Fisheries of the University of Ghana (UG) in Accra, with a goal of not only increasing the capabilities of Ghana to monitor and manage their coast, but to develop UG as a center of research excellence for the Gulf of Guinea region.

## OBJECTIVES

The objectives of the research activities were to provide guidance and technical assistance to the coastal processes research program at the Department of Oceanography and Fisheries, University of Ghana, Accra, Ghana. Development of this program is anticipated to aid maritime governance capabilities and social stability within Ghana. Over the short term, the goal was to assist with the development of the capabilities UG needed to assess local coastal processes and hazards and to provide technical assistance for ongoing monitoring of coastal change. Development of technological capabilities (coastal processes expertise, terrestrial surveying, bathymetric surveying, wave computation, coastal change modeling, GIS skills) was intended to lead to a self-sustaining research group at the University of Ghana that can then independently pursue other research questions and seek other party funding, both locally and internationally. In 2009-2011, the PIs served in an advisory role by providing technical assistance associated with coastal processes research conducted by the UG (PI Wiafe), with particular emphasis on shoreline change mapping and geomorphic characterization.

## APPROACH

This project consisted of technical advising and the development of collaborations between the PIs and UG scientists. The primary means of interaction has been periodic interaction via email and telephone conversations, visits by UG researchers to WHOI, and yearly trips by the PIs to UG to engage directly with the researchers, students, and staff at UG. The initial visit, occurring in February 2009, was a week-long workshop at the University of Ghana in which included scientific presentations, field visits that included collection of preliminary topographic survey data, hands-on computer analysis exercises, and small-group discussions. A second visit by the PIs to Ghana in June of 2010 included a more

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intense field effort followed by detailed discussions regarding development of publications and discussing future project direction and needs. Additional interactions between UG and USGS included ongoing assessments of historical imagery and maps for coastal change analyses and a visit to WHOI by a UG faculty member during April of 2010. A final project workshop was held in November 2011 and all project PIs, including those from UG, presented the results of their data collection and analyses. The PIs attended other workshops with Ghana coastal planners and agencies, and participated in some field data collection.

## WORK COMPLETED

Work completed includes several workshops, fieldwork to characterize the coastline and collect geological data, and technical training sessions. In February of 2009, Cheryl Hapke of the U.S. Geological Survey (USGS) and Andrew Ashton of the Woods Hole Oceanographic Institution (WHOI) participated in a workshop and technical training session with UG researchers and students. The goals of the workshop were:

- Continued development of a strategic research plan to understand and monitor coastal processes along the Ghanaian coast at a variety of temporal and spatial scales.
- Acquisition of techniques to understand long-term coastal evolution through aerial photography, historic maps, numerical modeling, and satellite imagery.
- Expansion of international collaborations.
- Visiting of coastal locations of varying geomorphic types to assess coastal hazards and processes, particularly to understand the influence of geologic setting and history on active processes and current change.
- Initial field deployments of equipment to create a baseline survey of the Ghanaian beaches and coastal features.

This successful workshop resulted in the sharing of technical and scientific knowledge and approaches (Fig 1) and established fruitful collaboration between participants. In June of 2010, Hapke and Ashton again traveled to Ghana to undertake fieldwork, updates on historical data acquisition and processing, and continued scientific discussions. Participants included ONR-funded researchers Ashton and Hapke, and researchers in the Department of Oceanography and Fisheries, University of Ghana (UG), Accra, Ghana, including George Wiafe, Selorm Ababio, Kwasi Appeaning Addo, and Kwame Adu Agyekum. Prior to the site visit, Hapke assisted with the identification and acquisition of historical maps of the Ghana coast from the U.S. National Archives in College Park MD.

***Figure 1. Knowledge exchange and data collection techniques were the objectives of the 2009 workshop.***

One primary focus of the 2010 workshop was to undertake a field survey of the entire Ghana coast (Fig. 2) with the objectives of:

- Conducting regional geomorphic characterization
- Assessing present state of erosion hazard/ hazard potential
- Collecting beach sediment samples for assessment of grain size
- Engaging in field discussions of coastal processes and the impacts of shoreline-erosion mitigation measures
- Collecting ground-penetrating Radar (GPR) data in beach ridge and delta locations


***Figure 2. Variable geomorphology and erosion hazards along the coastline of Ghana: (a) collecting GPR data near New Town; (b) actively eroding coastal bluffs at Old Ningo; (c) lagoonal clays (arrow) exposed in beach face at Akpabanya; (d) lagoonal clays (arrow) exposed in eroding road grade, Akplortorkor.***

Following the field survey in 2010 participants engaged in discussions at UG, including updates by UG faculty and students on data collection, processing and analysis of regional shoreline change and local beach monitoring studies; issues and troubleshooting of existing shoreline change data; presentation of theoretical aspects of coastal evolution by Ashton that are likely applicable to understanding chronic erosion hazards along portions of the Volta Delta; and detailed discussion and formulation of publications that would be developed as a result of the collaborative research efforts.

Ongoing collaborations were planned to finalize a systematic analysis of recent and historical data appropriate for regional change analyses.

A final workshop and field work were conducted in November 2011 and included UG participants, Hapke and Ashton, as well as collaborators from the University of New Hampshire (Tom Lippmann) and UNESCO-IHE (Dano Roelvink).

## RESULTS

The successful fieldwork and subsequent collaborative discussions resulted in significant improvement of an understanding of the regional coastal geology and geomorphology of the Ghana coast. Ten site visits were undertaken, covering the extent of Ghana's 550 km coast, extending from Newtown at the Côte d'Ivoire-Ghana border in the west to Denu, near the eastern border of Ghana and Togo. At each site, a description of the general geomorphology was recorded (barrier beach, bluffed coast, rocky coast, river mouth etc.), along with GPS location and descriptive measurements such as beach width and height of back beach feature (dune or bluff). A sample of beach sediment was also collected at each site to examine the regional distribution of grain size and variation in composition. Ground penetrating radar (GPR) data were collected at 3 additional sites: Newtown (a region that has not previously been surveyed with GPR) and 2 locations within the extensive Volta Delta complex.

The site visits and ensuing collaborations were the focus of an invited abstract that was presented as part of the Nearshore Processes session at the American Geophysical Union meeting in San Francisco, CA in December 2010 (Hapke et al., 2010).

The results of the regional shoreline change analysis (Fig. 3) indicate that other than a few isolated locations, the coastline of Ghana is undergoing widespread erosion, with a mean rate of -1.5 m/yr. Ninety percent of the coast is eroding, and the variability in erosion rates corresponds to the variation in geology and geomorphology slong the coast. Wave frocing likely also plays a role, although observational data of the variable wave climate is limited.

## IMPACT/APPLICATIONS

This project addresses the overarching goal of improving maritime security in the Gulf of Guinea, and specifically in Ghana. A short-term impact will be assessment of coastal change hazards along the Ghana coast and development of a research plan to increase coastal safety through hazard identification and mitigation. Research over the project duration (2009-2011), with visits to Ghana and in the US, continued the development of scientific relationships between the PIs and African coastal researchers. Over the long term, the objective was met to develop the independent research capabilities of the University of Ghana to improve the national capabilities in coastal hazards management and eventually maritime and fisheries management.

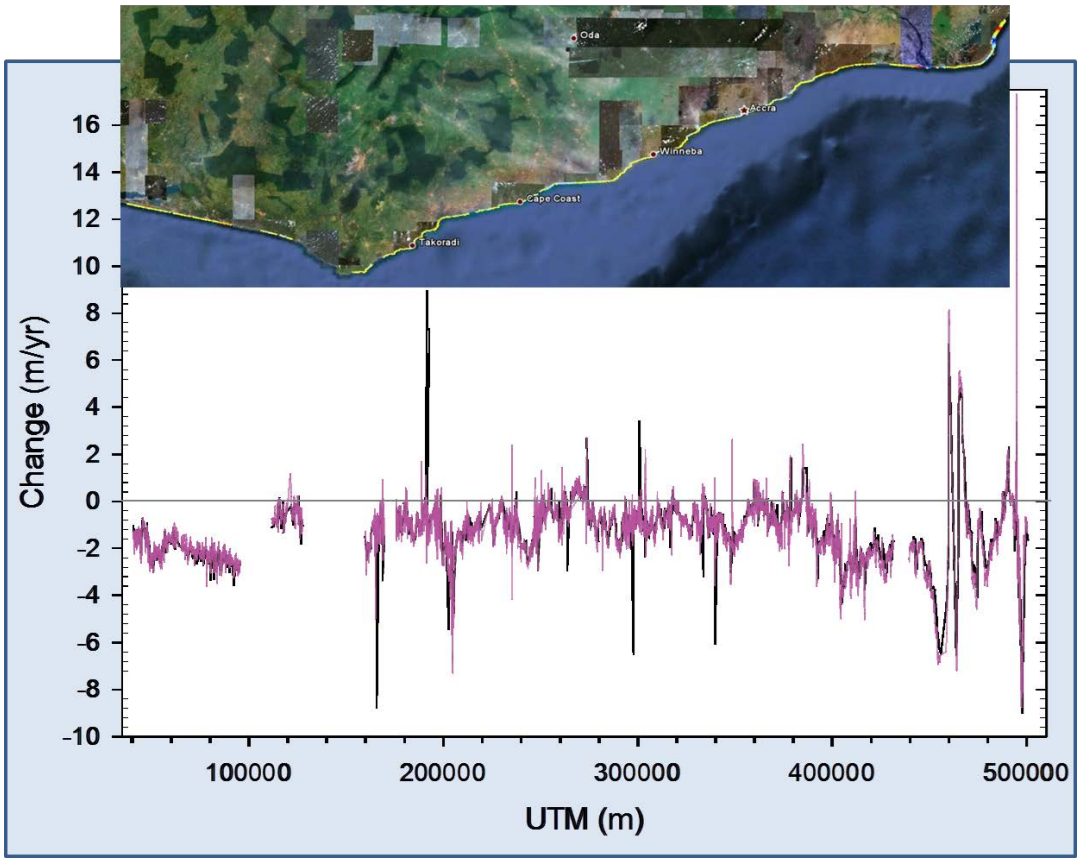


***Figure 3. Results of historical shoreline change analysis from 1974-2005) show that erosion along the Gnana coast is widespread, with an average erosion rate of 1.5 m/yr.***

## RELATED PROJECTS

Award Number: N00014-10-IP-20085; Preliminary Investigations of Erosional and Accretional Hotspots along the Ghanaian Coast (Alex Apostos, USGS).

## REFERENCES

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